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REGRES - A MICROCOMPUTER PROGRAM THAT CALCULATES THE COEFFICIENTS OF AN N-TH ORDER EQUATION BY THE METHOD OF LEAST SQUARES

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REGRES - A MICROCOMPUTER PROGRAM THAT CALCULATES THE COEFFICIENTS OF AN N-TH ORDER EQUATION BY THE METHOD OF LEAST SQUARES

by

K. Bartels* and P.L. Bedard**

SUMMARY

REGRES is a computer program which calculates the coefficients of an n-th order equation using the method of least squares. The equation is of the form $Y = C+A1X+A2X^2+ \ldots AnX^n$, where Y is the dependent variable, C is a constant, A1, A2 ... An are the coefficients of the variables X, X^2, ... X^n, respectively. In addition to the coefficients of X, the coefficient of determination, the coefficient of correlation and standard error of estimate are calculated and printed. It is necessary to provide at least (n+2) X,Y data points for each calculation. Once the equation has been calculated, values of Y may be predicted for given values of X. The program has been written in Microsoft BASIC-80*** and is intended to run on any of the popular microcomputers for which an "extended" type of BASIC is available.

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RESUME

"REGRES" est un programme d'ordinateur qui calcule les coefficients d'équation d'ordre n'ieme utilisant la méthode du moindres carrés. L'équation est de forme $Y = C+A1X, A2X^2+ \ldots AnX^n$ ou Y est la variable dépendante, C est la constante, A1, A2 ... An sont les coefficients des variables X, X^2 ... X^n, respectivement. En addition aux coefficients de X, le coefficient de détermination, le coefficient de corrélation et l'erreur standard sont calculés et imprimés. Il est necessaire pour chaque calcul de donner un minimum de (n+2) pour les données X,Y. Après que l'équation a été calculée, les valeurs de Y peuvent être pronostiquées pour une valeur donnée de X. Le programme a été écrit dans le langage "Microsoft BASIC-80" et est destiné à fonctionner sur n'importe quel micro-ordinateur populaire pour leqeul une version de "BASIC" est disponible.

INTRODUCTION

REGRES was adapted from a program by Borchers and Poole (1) to calculate the coefficients of a polynomial equation for inputed data sets. In adapting REGRES, an attempt was made to write a program which could be easily executed by non-programmers. It is one of the major advantages of microcomputers that, given the availability of "user-friendly" software, users who are not themsleves programmers may take full advantage of the computational, word processing or record/data base keeping abilities of microcomputers. Therefore, it is only necessary for the user to provide the required X,Y data points and to follow the instructions on the screen to generate a printout of the calculated coefficients of the polynomial equation. It is the purpose of this report to provide the documentation and source code for the REGRES program.

PROGRAM DESCRIPTION

PROGRAM CONCEPT

REGRES is a computer program which calculates the coefficients of an n-th order equation using the method of least squares. The equation is of the form

$$Y = C + A_1X + A_2X^2 + \ldots A_nX^n \qquad \text{(Eq. 1)}$$

where Y is the dependent variable, C is a constant, A1, A2 ... An are the coefficients of the variables X, X^2, ... X^n, respectively. In addition to the coefficients of X and C , the coefficient of determination, the coefficient of correlation and standard error of estimate are calculated and printed. In order to solve the system of equations generated by the least squares matrix, the number of observed data pairs must be at least the

order of regression plus 2 (e.g., at least five data pairs must be provided when solving a third order equation). Once the equation has been calculated, values of Y may be predicted for given values of X.

DETAILS OF DATA ENTRY

REGRES has been designed to make full use of BASIC's ability to prompt the user for the required information and to request it in the correct sequence. The following is the sequence of screen prompts and queries initiated by REGRES:

Screen 1

REGRES Logo and a request to initialize printer.

Display of information about and instructions for the use of REGRES.

Screen 2

Request for DATE of calculation.

Request for calculation IDENTIFIER or COMMENT.

Request for DEGREE of equation.

Display of chosen equation.

Request for number of known points.

Screen 3

Request for X,Y data sets.

Screen 4

Calculation of predicted values of Y for given values of X.

In order to minimize errors, program variables A and those from P to Z (Appendix II) have been declared double precision.

PROGRAM EXAMPLE

A typical use of REGRES is that of calculating the coefficients of a temperature vs concentration curve from a series of measured data points. Assuming that temperature is the independent variable and that changes in concentration with respect to temperature closely follow a parabolic relationship, Eqn. 1 may be re-written as:

$$Y = C + A_1T + A_2T^2 \qquad \text{(Eq. 2)}$$

where Y is the concentration in g/L and T is the temperature in ^{o}C.

Table 1. Measured concentrations at temperatures between 20 and 70°C

Temperature (^{o}C)	Concentration (g/L)
20	5.4
30	9.0
40	13.8
50	20.6
60	29.2
70	39.6

Given that concentration versus temperature measurements have established the values shown in Table 1, constant C, the equation coefficients, the coefficient of determination, coefficient of correlation and the standard error estimate will be calculated from the above measured values of X and Y. Also, a printout of the DATE and the calculation IDENTIFIER is provided.

Given that for parabolic equation 2, the above data points and the following are entered at the keyboard:

a) Date: FEB 24/84

b) Sample Identifier: LEAD #34

a printout such as that shown in Appendix I is obtained when REGRES is run.

This would complete a typical run of REGRES. At the end of the program the user has the option of proceeding with another calculation or stopping the program. The constant C and the calculated equation coefficients obtained from REGRES, would normally be used in a program such as CLCEQN (Report number 84-37 (TR)) to generate a table of interpolated values in Y for a given range in X.

DESCRIPTION OF SOURCE CODE

A complete listing of the BASIC source code and a cross-reference table of the variables and statement entries for REGRES are given in Appendix II. The source code documentation includes general comments, a list of variables and an explanation of how these are used. In addition, the following should be noted.

a) Hardware dependent installation

To enhance both screen and printer output, several control codes have been defined. These are CLEAR SCREEN (CLS$), INVERSE VIDEO ON (RO$), and INVERSE VIDEO OFF (RF$). These are located at line 500 and should be changed to those required for a particular hardware configuration. Control sequences used in this program are those for the "NorthStar Advantage" microcomputer. Control sequences not supported by a particular terminal should be set to "null".

b) DIMensioning of the program

The present version of this program has been DIMensioned to allow a maximum order of 6 for the general equation (Eqn. 1). The dimensioning is determined by the matrix requirements of the least squares procedure used so that DIMensioning follows the scheme

```
DIM A(2xD+1), R(D+1,D+2), T(D+2)
```

where D is the maximum allowed degree of the equation. In the case of degree 6, the DIM statement is defined as

```
DIM  A(2x6+1), R(6+1,6+2), T(6+2)
```

or simply

```
DIM A(13),R(7,8),T(8)
```

Line 430 should be changed accordingly if orders above 6 are required.

c) Program and system requirements and program availability

REGRES is written in Microsoft BASIC-80, requiring at least 24K of RAM memory for the Microsoft BASIC-80 Interpreter. Use of a version compiled with the Microsoft BASIC-80 Compiler is useful but not required as only one data pair is processed at a time. After loading the operating system the interpreter and this version of REGRES as it is DIMensioned, about 23000 bytes of RAM memory remain unused in the TPA (Transient Program Area) of a typical 64K RAM microcomputing system.

CONCLUSION

REGRES is a useful BASIC version of a least squares procedure which easily handles simple polynomial regression analyses. It does not, however, resolve multi-parameter functions of the type Y=f(X,T) that are more efficiently handled by larger FORTRAN mainframe programs. The REGRES program is eminently suited to a microprocessor in that it enables easy data entry and use by personnel not expert in high-level language programming. In addition to avoiding the considerable costs associated with batch processing in a time-sharing mainframe environment, it offers the user the ability to interact directly with the program while entering and processing data.

ACKNOWLEDGEMENT

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REFERENCES

1 - Borchers, M. and Poole, L. "Some common BASIC programs"; Adam Osborne and Associates Inc.; Berkeley, California; 151-153; 1977.

APPENDIX I

PRINTOUT OF RESULTS PRODUCED BY REGRES

> NTH-ORDER REGRESSION <

Date: FEB 24/84

Calculation: LEAD #34

The requested equation is:

Y = C + A(1)*X + A(2)*X^2

NUMBER of known points: 6

X(KNOWN)	Y(KNOWN)
20.00000	5.40000
30.00000	9.00000
40.00000	13.80000
50.00000	20.60000
60.00000	29.20000
70.00000	39.60000

C ->	CONSTANT (AT X=0) ..... =	4.177280
A1 ->	COEFFICIENT ..... =	-0.109578
A2 ->	COEFFICIENT ..... =	0.008786
->	COEFFICIENT OF DETERMINATION (R^2) =	0.999928
->	COEFFICIENT OF CORRELATION =	0.999964
->	STANDARD ERROR OF ESTIMATE =	0.141975

X(ENTERED)	Y(CALC)
25.00000	6.92894

APPENDIX II

SOURCE CODE LISTING OF REGRES

```
100 REM                    == REGRES ==
110 REM - THIS PROGRAM CALCULATES THE COEFFICIENTS OF AN NTH
120 REM   ORDER EQUATION USING THE METHOD OF LEAST SQUARES -
130 REM
140 REM - ADAPTED BY K. BARTELS AND P. BEDARD (CANMET-EMR)
150 REM   FROM BORCHERS, M. AND POOLE, L., 'SOME COMMON BASIC PROGRAMS',
160 REM   ADAM OSBORNE AND ASSOCIATES INC., BERKELEY, CALIFORNIA,
170 REM   PP. 151-153, 1977
180 REM
190 REM - JANUARY 1984 -
200 REM
210 REM - VARIABLES USED -
220 REM
230 REM A ..... MATRIX VARIABLE
240 REM CT$ ..... SUMMATIONS FOR EQUATION STRINGS
250 REM COM$ .... COMMENT OR CALCULATION IDENTIFIER
260 REM D ..... MAXIMUM DEGREE OF EQUATION
270 REM DT$ ..... DATE
280 REM IL ..... LENGTH OF EQUATION STRINGS
290 REM IM ..... PAGE CENTERING VARIABLE
300 REM J ..... INDEX AND REGRESSION VARIABLE
310 REM N ..... NUMBER OF KNOWN POINTS
320 REM P ..... REGRESSION VARIABLE
330 REM Q ..... REGRESSION VARIABLE
340 REM R ..... MATRIX VARIABLE
350 REM R$ ..... RESPONSE VARIABLE
360 REM S ..... MATRIX VARIABLE
370 REM T ..... MATRIX VARIABLE
380 REM X ..... INDEPENDENT VARIABLE
390 REM Y ..... DEPENDENT VARIABLE
400 REM Z ..... MATRIX VARIABLE
410 REM
420 DEFDBL A,P-Z
430 DIM A(13),R(7,8),T(8)
440 REM
450 REM - DEFINE SCREEN CONTROL CODES -
460 REM   (Currently set for 'NORTHSTAR ADVANTAGE')
470 REM
480 REM - CLEAR SCREEN, INVERSE VIDEO ON/OFF -
490 REM
500 CLS$=CHR$(4):RO$=CHR$(1):RF$=CHR$(2)
510 REM
520 REM - DEFINE STRING VARIABLES -
530 REM
540 CO$="Y = C + ":CO1$="A(1)*X":CO2$=" + A(2)*X^2"
550 CO3$=" + A(3)*X^3":CO4$=" + A(4)*X^4"
560 CO5$=" + A(5)*X^5":CO6$=" + A(6)*X^6"
570 CO7$="   Y = C + A(1)*X + A(2)*X^2 + ... A("
580 CO8$="Y = C + A(1)*X + A(2)*X^2 + ... A(N)*X^N"
590 CK$=" NUMBER of known points: "
600 CN$="C  -) CONSTANT (AT X=0) ..... = "
610 CN$=" -) COEFFICIENT ..... = "
620 CD$="   -) COEFFICIENT OF DETERMINATION (R^2) = "
630 CP$="   -) COEFFICIENT OF CORRELATION       = "
640 CD$="   -) STANDARD ERROR OF ESTIMATE       = "
650 CX$=") Please hit any key to continue ..."
660 REM
```

```
670 PRINT CLS$;SPC(24);RD$;
680 PRINT") NTH-ORDER REGRESSION (":PRINT RF$
690 PRINT") Please initialize printer and hit any key to continue ..."
700 R$=INKEY$:IF R$="" THEN 700
710 GOSUB 2550:REM PRINT TITLE LINE
720 GOSUB 2570:REM PRINT UNDERLINE
730 LPRINT SPC(20);") NTH-ORDER REGRESSION ("
740 GOSUB 2570:REM PRINT UNDERLINE
750 LPRINT
760 PRINT") ADAPTED BY K. BARTELS AND P. BEDARD FROM:":PRINT
770 PRINT"  BORCHERS, M. AND POOLE L., 'SOME ";
780 PRINT"COMMON BASIC PROGRAMS', ADAM OSBORNE"
790 PRINT"  AND ASSOCIATES INC., BERKELEY, ";
800 PRINT"CALIFORNIA, PP. 151-153, 1977"
810 PRINT
820 PRINT") AT PRESENT THE PROGRAM HAS BEEN ";
830 PRINT"DIMENSIONED FOR REGRESSIONS UP TO"
840 PRINT"  THE 6TH ORDER. THESE DIMENSIONS MAY ";
850 PRINT"EASILY BE CHANGED IN LINE 430"
860 PRINT
870 PRINT") THIS PROGRAM FINDS THE COEFFICIENTS OF AN ";
880 PRINT"NTH ORDER EQUATION USING"
890 PRINT"  THE METHOD OF LEAST SQUARES. THE EQUATION ";
900 PRINT"IS OF THE FOLLOWING FORM:"
910 PRINT
920 PRINT TAB(18);RD$;CD$;RF$;:PRINT:PRINT
930 PRINT"  WHERE:    Y = DEPENDENT VARIABLE"
940 PRINT"            C = CONSTANT"
950 PRINT"            A(1),A(2) ... A(N) ARE THE COEFFICIENTS OF INDEPENDENT"
960 PRINT SPC(30);"VARIABLES X,X^2, ... X^N RESPECTIVELY"
970 PRINT:PRINT") AT LEAST N+2  X- AND Y- COORDINATES ";
980 PRINT"OF KNOWN DATA POINTS MUST BE PROVIDED"
990 REM
1000 REM - SET LIMITS ON DEGREE OF EQUATION TO A(2D+1),R(D+1,D+2),T(D+2)
1010 REM   (WHERE D = MAX. DEGREE OF EQUATION) -
1020 REM
1030 PRINT CK$;
1040 R$=INKEY$:IF R$="" THEN 1040
1050 PRINT CLS$
1060 INPUT") Please enter today's DATE: ";DT$
1070 PRINT:PRINT") Please enter the calculation IDENTIFIER or COMMENT: "
1080 INPUT COM$
1090 PRINT:INPUT") Please enter DEGREE of equation: ";D
1100 LPRINT"Date: ";DT$:LPRINT:LPRINT"Calculation: ";COM$:LPRINT
1110 LPRINT:LPRINT SPC(25);"  The requested equation is:"
1120 LPRINT
1130 PRINT:PRINT"  The requested equation is:":PRINT
1140 IF D>6 THEN GOSUB 2580 ELSE GOSUB 2280:REM PRINT EQN'S GREATER THAN X^6
1150 PRINT CK$;:INPUT N
1160 LPRINT SPC(25);CK$;N
1170 LPRINT:LPRINT SPC(24);"X(KNOWN)";SPC(16);"Y(KNOWN)"
1180 LPRINT SPC(24);"=========";SPC(16);"========="
1190 A(1)=N
1200 REM
1210 REM - ENTER COORDINATES OF DATA POINTS -
1220 REM
1230 PRINT CLS$;SPC(11);") Please enter values of X and Y for known points:":
```

'REGRES.BAS' - APPENDIX II

```
1240 PRINT:PRINT SPC(25);"X (RETURN), Y (RETURN)"
1250 PRINT
1260 FOR I=1 TO N
1270 PRINT SPC(30);"X(";I;")= ";:INPUT X:PRINT SPC(30);"Y(";I;")= ";:INPUT Y
1280 LPRINT SPC(23);:
1290 LPRINT USING "###.#####";X;:LPRINT SPC(15);:LPRINT USING "###.#####";Y
1300 REM
1310 REM - LINES 1280 TO 1360 POPULATE MATRICES WITH SPECIFIC EQUATIONS -
1320 REM
1330 FOR J=2 TO 2*D+1
1340 A(J)=A(J)+X^(J-1)
1350 NEXT J
1360 FOR K=1 TO D+1
1370 R(K,D+2)=T(K)+Y*X^(K-1)
1380 T(K)=T(K)+Y*X^(K-1)
1390 NEXT K
1400 T(D+2)=T(D+2)+Y^2
1410 NEXT I
1420 REM
1430 REM - LINES 1400 TO 1680 SOLVE THE SYSTEMS OF EQUATIONS IN THE MATRICES -
1440 REM
1450 FOR J=1 TO D+1
1460 FOR K=1 TO D+1
1470 R(J,K)=A(J+K-1)
1480 NEXT K
1490 NEXT J
1500 FOR J=1 TO D+1
1510 FOR K=J TO D+1
1520 IF R(K,J)=0 THEN NEXT K:GOTO 2210
1530 FOR I=1 TO D+2
1540 S=R(J,I)
1550 R(J,I)=R(K,I)
1560 R(K,I)=S
1570 NEXT I
1580 Z=1/R(J,J)
1590 FOR I=1 TO D+2
1600 R(J,I)=Z*R(J,I)
1610 NEXT I
1620 FOR K=1 TO D+1
1630 IF K=J THEN 1680
1640 Z=-R(K,J)
1650 FOR I=1 TO D+2
1660 R(K,I)=R(K,I)+Z*R(J,I)
1670 NEXT I
1680 NEXT K
1690 NEXT J
1700 PRINT:PRINT CHR$;:PRINT USING"####.######";R(1,D+2)
1710 LPRINT:LPRINT SPC(11);CHR$;:LPRINT USING"####.######";R(1,D+2)
1720 FOR J=1 TO D
1730 PRINT"A";:PRINT USING"#";J;
1740 LPRINT SPC(11);"A";:LPRINT USING"#";J;
1750 PRINT CHR$;:PRINT USING"####.######";R(J+1,D+2)
1760 LPRINT CHR$;:LPRINT USING"####.######";R(J+1,D+2)
1770 NEXT J
1780 PRINT:LPRINT
1790 REM
1800 REM - COMPUTE REGRESSION ANALYSIS -
```

'REGRES.BAS' - APPENDIX II

```
1810 REM
1820 P=0
1830 FOR J=2 TO D+1
1840 P=P+R(J,D+2)*(T(J)-A(J)*T(1)/N)
1850 NEXT J
1860 Q=T(D+2)-T(1)^2/N
1870 Z=Q-P
1880 I=N-D-1
1890 J=P/Q
1900 PRINT CD$;:PRINT USING"####.######";J
1910 LPRINT SPC(11);CD$;:LPRINT USING"####.######";J
1920 PRINT CP$;:PRINT USING"####.######";SQR(ABS(J))
1930 LPRINT SPC(11);CP$;:LPRINT USING"####.######";SQR(ABS(J))
1940 PRINT CD$;:PRINT USING"####.######";SQR(ABS(Z/I))
1950 LPRINT SPC(11);CD$;:LPRINT USING"####.######";SQR(ABS(Z/I))
1960 PRINT:LPRINT:LPRINT:LPRINT SPC(22);"X(ENTERED)";SPC(17);"Y(CALC)"
1970 LPRINT SPC(22);"==========";SPC(16);"========"
1980 REM
1990 REM - COMPUTE Y-COORDINATE FROM ENTERED X-COORDINATE -
2000 REM
2010 PRINT CX$;
2020 R$=INKEY$:IF R$="" THEN 2020
2030 PRINT CL$
2040 PRINT SPC(18);") To calculate predicted value of 'Y'"
2050 PRINT SPC(18);"  please enter the value of 'X'"
2060 PRINT SPC(18);") To STOP, enter the value of 0 for 'X'"
2070 PRINT
2080 P=R(1,D+2)
2090 PRINT SPC(30);"X=";:INPUT X
2100 IF X=0 THEN 2190
2110 FOR J=1 TO D
2120 P=P+R(J+1,D+2)*X^J
2130 NEXT J
2140 PRINT SPC(30);"Y= ";:PRINT USING"###.####";P
2150 LPRINT SPC(23);
2160 LPRINT USING"###.######";X;:LPRINT SPC(15);:LPRINT USING"###.######";P
2170 PRINT
2180 GOTO 2000
2190 PRINT:GOSUB 2550:REM PRINT TITLE LINE
2200 LPRINT CHR$(12):GOTO 2230:REM ANOTHER EQUATION ?
2210 PRINT"!!! NO UNIQUE SOLUTION !!!";CHR$(7)
2220 LPRINT"!!! NO UNIQUE SOLUTION !!!"
2230 INPUT") Do you want to calculate the coefficients of another equation ";R$
2240 IF LEFT$(R$,1)="Y" OR LEFT$(R$,1)="y" THEN 500 ELSE END
2250 REM
2260 REM - PRINT THE EQUATION -
2270 REM
2280 PRINT"   ";R0$;"   ";
2290 ON D GOTO 2310,2350,2390,2430,2470,2510
2300 PRINT R0$
2310 CT$=CD$+CB1$
2320 GOSUB 2610:REM END OF LOOP
2330 PRINT CT$;
2340 GOTO 2540
2350 CT$=CD$+CB1$+CB2$
2360 GOSUB 2610:REM END OF LOOP
2370 PRINT CT$;
```

'REGRES.BAS' - APPENDIX II

```
2380 GOTO 2540
2390 CT$=CD6+CD10+CD20+CD30
2400 GOSUB 2610:REM END OF LOOP
2410 PRINT CT$;
2420 GOTO 2540
2430 CT$=CD6+CD10+CD20+CD30+CD40
2440 GOSUB 2610:REM END OF LOOP
2450 PRINT CT$
2460 GOTO 2540
2470 CT$=CD6+CD10+CD20+CD30+CD40+CD50
2480 GOSUB 2610:REM END OF LOOP
2490 PRINT CT$
2500 GOTO 2540
2510 CT$=CD6+CD10+CD20+CD30+CD40+CD50+CD60
2520 GOSUB 2610:REM END OF LOOP
2530 PRINT CT$
2540 LPRINT:PRINT"   ";RF$:PRINT:RETURN
2550 LPRINT"═══════════════════════════════════════════════════════════════════════"
2560 LPRINT:LPRINT:RETURN
2570 LPRINT SPC(20);"═══════════════════":RETURN
2580 LPRINT SPC(20);CD7$;:LPRINT USING"#";D;:LPRINT")X"";:LPRINT USING"#";D
2590 PRINT CD7$;:PRINT USING"#";D;:PRINT ")X"";:PRINT USING"#";D
2600 PRINT:RETURN
2610 IL=LEN(CT$)
2620 IM=(80-IL)/2
2630 LPRINT SPC(IM);CT$
2640 RETURN
```

'REGRES.BAS' - APPENDIX II

SYMBOL	REFERENCE LINE						
300	2240						
700	700						
1040	1040						
1480	1630						
2020	2020						
2080	2180						
2190	2180						
2210	1520						
2230	2200						
2280	1140						
2310	2290						
2350	2290						
2390	2290						
2430	2290						
2470	2290						
2510	2290						
2540	2340	2380	2420	2460	2500		
2550	710	2190					
2570	720	740					
2580	1140						
2610	2320	2360	2400	2440	2480	2520	
A	420						
AK	430	1190	1340	1470	1840		
CD6	540	2310	2350	2390	2430	2470	2510
CD16	540	2310	2350	2390	2430	2470	2510
CD26	540	2350	2390	2430	2470	2510	
CD36	550	2390	2430	2470	2510		
CD46	550	2430	2470	2510			
CD56	560	2470	2510				
CD66	560	2510					
CD76	570	2580	2590				
CD86	580	920					
CD9	590	1150	1160				
CLS6	580	670	1050	1230	2030		
CM6	600	1700	1710				
CM8	610	1750	1760				
CO6	620	1900	1910				
CO16	1000	1100					
CP6	630	1920	1930				

'REGRES.BAS' - APPENDIX II

SYMBOL	REFERENCE LINE												
CD$	640	1940	1950										
CT$	2310	2330	2350	2370	2390	2410	2430	2450	2470	2490	2510	2530	2611
	2630												
CX$	630	1830	2010										
D	1090	1140	1330	1360	1370	1400	1450	1460	1500	1510	1530	1590	1620
	1650	1700	1710	1720	1750	1760	1830	1900	1960	1980	2000	2110	2121
	2290	2500	2590										
DT$	1060	1100											
I	1260	1270	1410	1530	1540	1550	1560	1570	1590	1600	1610	1650	1660
	1670	1800	1940	1950									
IL	2610	2620											
IM	2620	2630											
J	1330	1340	1350	1450	1470	1490	1500	1510	1520	1540	1550	1580	1600
	1630	1640	1660	1690	1720	1730	1740	1750	1760	1770	1830	1900	1920
	1890	1900	1910	1920	1930	2110	2120	2130					
K	1360	1370	1380	1390	1460	1470	1480	1510	1520	1550	1560	1620	1630
	1640	1660	1680										
N	1150	1160	1190	1260	1840	1860	1880						
P	420	1820	1840	1870	1890	2000	2120	2140	2160				
Q	1860	1870	1890										
RB	700	1940	2020	2230	2240								
RK	430	1370	1470	1520	1540	1550	1560	1580	1600	1640	1660	1700	1710
	1750	1760	1840	2000	2120								
RP$	500	600	920	2540									
RD$	500	670	920	2200	2300								
S	1540	1560											
T(	430	1370	1380	1400	1840	1860							
X	1270	1290	1340	1370	1380	2090	2100	2120	2160				
Y	1270	1290	1370	1380	1400								
Z	420	1580	1600	1640	1660	1870	1940	1950					

LINES: 255 BYTES: 8943 SYMBOLS: 61 REFERENCES: 302